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Energy Efficiency Building Codes and Green Pyramid Rating System

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Abstract: ***Three Building Energy Codes were introduced in Egypt between 2005 and 2010. They impose mandatory energy performance requirements for residential, commercial and Governmental buildings. Another Code was presented (2013) to improve the indoor air quality and ventilation requirements and system. This paper addresses the current states and the potential of Energy Efficiency, Renewable Energy and Green Buildings to reduce the depends of the fossil fuel. These codes were the base line for Green Building Code. The first edition of the Green Pyramid Rating System was published in December 2010. The green Pyramid Rating System is a national environmental rating system for buildings. It provides definitive criteria by which the environmental credentials of buildings can be evaluated, and the building themselves can be rated. The Egyptian Government has an interest in promoting green buildings as part Egyptian policy overall sustainable development policies. HBRC establish the Egyptian Green Building Council (GBC-Egypt) at the beginning of 2009. Another Code (under preparations) for Green Hotel Rating System in Egypt to improve the Egyptian Touristic sector. The essence of this paper is to introduce the Egyptian Efforts to improve the quality of life and highlight the barriers and to over come the changeless that faces Egypt and are summarized only in three main parameters namely; energy, water and housing.***

Keywords: Energy Codes, Green Buildings and Green Pyramid rating System

1. Introduction

About two thirds of Egypt's total population of 90 million (2014) are living in urban areas. Egypt's population is concentrated in only 6% of the territory. About 30% of the Egyptian population is living in Cairo and Alexandria and about 65 % of total in Great Cairo and Delta. The Egyptian Building stock comprises about 12 million buildings and 60% of buildings units are in residential sector. The number of Residential is about 18 million [1] expecting to reach 23 million in 2030, while the number of nonresidential units is about 12 million and expecting to reach 17 million in 2030 [2]. In Egypt, more than 60% of the total electricity consumption is attributed to residential, commercial, and institutional buildings. Artificial lighting is estimated to account for 36% of the electricity used in the nonresidential sector and 35% of the electricity used for HVAC system. A significant increase in electricity demand is expected over the next five years with a growth rate of 8%. To improve the energy efficiency of Estimate indicates that energy consumption could be more than double in 2030 and triple in building sector. Building energy sector increases due to growing populations and comfort demand, electricity use of low income inhabitations. The household sector is the biggest consumer of electric energy and accounts for 43.3% [1]. The Egyptian energy tariffs are still very low with respect to other developing countries, but the new government starting increase of the electricity tariff in ?July 2014 for the next 5 years. The current national energy supply mix in Egypt is; 96% from fossil fuel; (petroleum products and natural gas); 4% from renewable recourses (mainly hydro and limited wind). buildings, an energy efficiency codes have been developed for new residential [3], non-residential [4] and Governmental buildings [5] in Egypt. Energy subsides is about 147 million only 6% from total subside goes to Residential Sector.

2. Key Issues and Challenges

The energy sector plays an important role in achieving the economical and social development in Egypt, through supplying the energy resources mix needed different sectors In 2009/2010, oil contribute 40% of total primary energy consumption while Natural Gas "**NG**" counted 56% (about 70% goes for electricity) and only 4% were from Renewable Energy "**RE**" including hydro recourses. The industrial and transport sectors are the largest end-use consumers of primary energy sources, counting for 34% respectively in 2009/2010. While for electricity consumption the domestic sector was the highest consumer for 39% followed by industries 32%, as shown in Fig.1.The passive design is the most cost effective to reduce the energy consumption through building envelope. Figure 2 shows [6] the design level from urban planning to architectural design [6] and it is cost effective energy efficient buildings. A good design can reduce the investment cost of a building, when considering compacts, efficient lay-outs and orientation.

Figure 1: Distribution of electricity consumption by sector

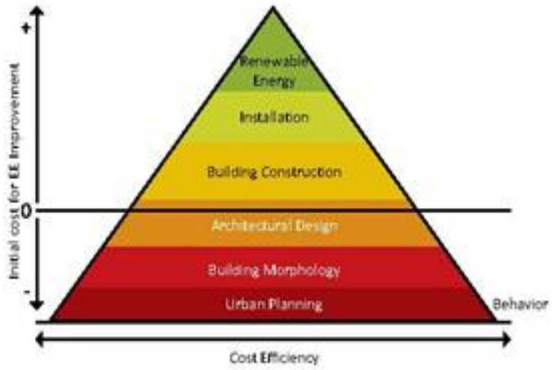

Figure 2: Strategy for cost Effective Energy Efficient Buildings.

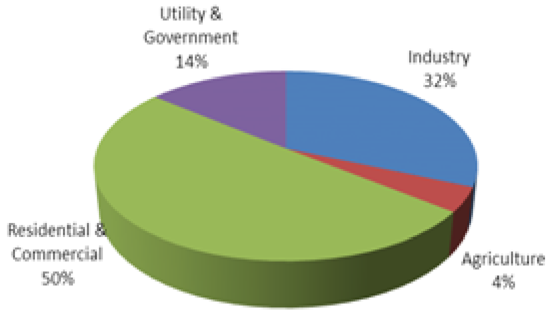

Figure 3: Primary Energy Consumption 2011/2012= 81.7 MTOE

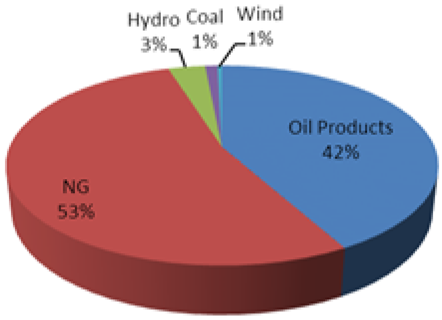

Figure 4: Total Electricity Consumption, 2011/2012= 134 Billion KWh

Analysis of Egyptian population quintiles [8] (20% population segments based on income, low-high) found that the riches quintile received 46% of the total benefits of petroleum subsidies, while the poorest urban quintile received only 9%. The stark divide illustrates the division in benefits of subsidies between rich and poor. A similar divides also exits both within urban and rural areas as well as between them, with benefits primarily going to urban rich, rather than the rural poor. These figures give strong evidence of the common reality of inequitable distribution of universal energy subsidies.

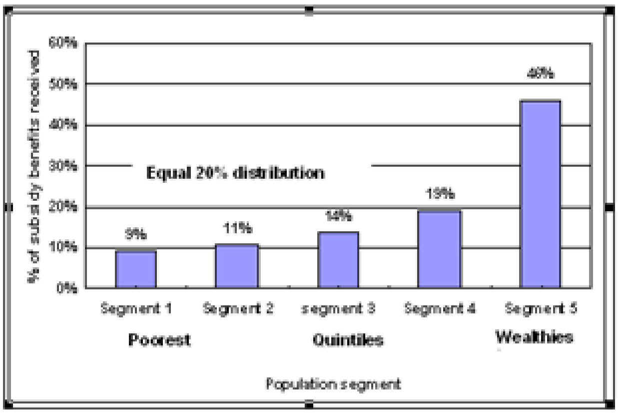

Figure 5: Distribution of Subsidy in Egypt

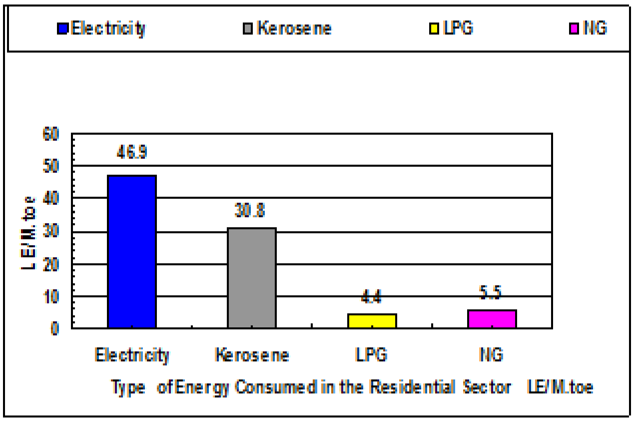

Figure 6: Energy Subsidy in Egypt

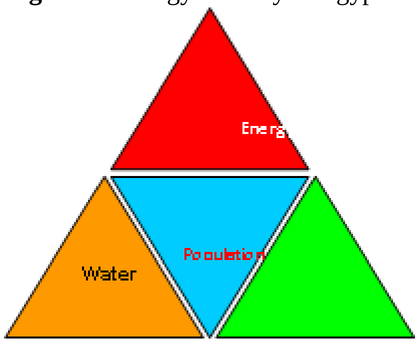

Figure 7: Egyptian Parries

The electricity generation activity utilizes around 30% of the fossil fuel and natural gas recourses in addition to all the hydro and wind energies recourses. The industrial activities in Egypt consume around 40% of the overall energy available. The average annual gross for energy use was less than 6% over the last decade and it is expected to continue if solve the decrease of energy problem. Actual data of electricity consumption are very limited. Surveys indicate that lighting and cooling are the most important end use of electricity in the residential sector. All account about 2/3 of consumption. The increase use of electricity for cooling adds sustainability to the peak load during summer, requiring new power stations. More than 3 Million AC was installed in the residential sector. About 13% of electricity of the electricity generated lost in the transmission lines and cables are lost when the ambient temperature reaches 40 ^{o}C or above in summer. The over heating period reaches about 5-6 months. The Ministry of Electricity and Energy must add about 10000 MWh in the next few years to overcome the cut in the supporting the houses by electricity. The second problem is housing for low income inhabitant. More than half of the new housing stock is built informally; the rest is shared the government and the private sector. Energy subside more than 140 B. Egyptian pounds which affects the other matter of life. The third problem is water. The Egyptian chair from river Nile is limited by 55.5 B.m^3 per year. Table (1) shows the primary energy indictor (Mtoe) and electricity consumption (GWh).

The New Government of Egypt after June 30, 2013 signed an agreement with United Arab Emirates represented by the ARABTEC Company and The Engineering Division in the Ministry of Defense to built one million residential unit in the next five years, i.e. 200000 unit/year for low income. Another million unites will established from Egyptian private investor's sector and GOE. These buildings must considered and apply the Egyptian Building Codes for Energy Efficiency and Green Building concept (envelope requirements, ventilation, WWR, SHGC & SWH in addition Energy labeled appliances) could save more than 50% from electricity consumed in residential sector. Egypt was among the first nations to use renewable energy resources, especially in solar architecture, crops dehydration, pumping and in using animals and agricultural wastes. The Egyptian renewable energy strategy [10]aims to generate 3% of the total electricity demand using renewable energy by 2014

Table 1: Indicator of Primary Energy (Mtoe)and Electricity Consumption (GWh)

Description	Energy	Electricity
Sectors	(Mtoe)	GWh
Industries	44%	32.5%
Agriculture	1%	4%
Transport	27%	0
Governmental Utilities	3%	10.5%
Residential, Governmental & Commercial	25%	52.6%
Total (Mtoe)	100%	99.7%

The estimated energy saving in some household and industrial applications is 90000 TOE, and 60000 TOE from electricity

generation using wind farms, in addition to 3.6 million TOE biomass. A new and renewable energy resource includes solar, wind and biomass. The energy utilization from such resources was estimated to be 150,000 TOE in 2003 plus 3.6 million TOE biomass.

2.1 Hydropower

Hydropower potential resources at Nagah Hamady and Assuit., as well as some other small available capacities at main canals of the river Nile, in delta, and at the Zefta barrages on Damietta Branch of the Nile. A feasibility station (pump and store) at Attaka and El-Gallala on the Red Sea is now being made. The share of hydro generation to the total generations represents about 8.2% in 2010-2012.

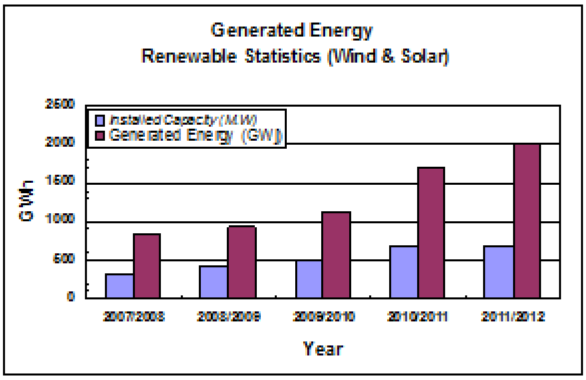

Figure 8: Generated Energy from solar and wind in Egypt 2011/2011 [1]

Table 2: Design Overall Thermal Transfer Values for Residential Buildings.

Description	Roof		Walls			
Thermal Indices	Ur (W/m^2.°C)	OTTV r (W/m^2)	U w (W/$m^{2.o}$C)	OTTV w (W/m^2)	WWR (%)	SHGC*
North Coast	≤0.40	≤ 20	≤ 1.4	≤ 95	>10% -- <30%	>0.4-<0.7
Cairo &, Delta	≤ 0.50	≤ 25	≤ 1.0	≤ 90	>10% - <20%	>0.45-<0.7
North Upper of Egypt	≤0.35	≤20	≤ 0.6	≤ 95	>10%- <20%	>0.42-<0.68
South Upper of Egypt	≤0.333	≤25	0.566 – 1.111	≤55	>10%- <20%	>0.4-<0.65
Eastern Coast	≤0.357	≤20	0.909 – 2.222	≤45	>10%- <20%	>0.4-<0.68
Highland Hills	≤0.500	-	0.83 - 1.0	-	>10% - <30%	---
Western Desert	≤0.333	≤25	≤55	0.71 - 1.25	>10% -- <20%	>0.55 -<0.71
Southern Egypt	≤0.333	≤25	0.667 – 1.000	≤60	>10% -- <20%	>0.4-<0.7

*depends on orientation of the main façade.

2.2. Solar Energy

Egypt lies between latitudes 22 and 32 with a daily 9 to 11 hours of sunshine. Solar energy is available in all regions with an average total solar radiation 1900-2600 kWh/m^2/year, while the direct solar radiation is 1970-3200 kWh/m^2/year. The first thermal power plant is constructed at El-Kuraymat, 50 Km south west of Cairo. The installed capacity is 140 MW out of which 20 MW is the capacity of solar component and using hybrid solar, combined cycle (**CC**) before introducing the steam turbine (**ST**) to generate electricity. The power Plant is financed from the Global Environmental Facility (**GEF**) and Japan Bank (**JICA**) for International Development. The project started in 30/6/2011 with estimated total energy generated of 852 GWh/year. This station will save about 10 thousand tones TOE and reduce the CO_2 emission by 20 thousand tones/year. A Solar Energy Program is implemented during the five started 2012-2017 for the concentrated solar power plants, with total capacity of 100 MW at Kom Ombo south of Egypt. New and Renewable Energy Authority (NREA) built and operated 547 MW of wind farm capacities and 140 MW solar thermal power plant using parabolic concentrators through technology integrated with combined cycle power plant. Twenty five

Governmental Office Buildings will apply PV Systems on the top roof as that applied in the Main Office of the Electricity Office Building in Cairo.

2.3 Wind Energy

Egypt is endowed with an abundance of wind energy resources especially in Suez Gulf area which considered one of the best sites in the world due to high and stable wind speeds. The West of Suez Gulf is the most promising sites in the Middle East and Africa. The wind speed ranges from 8-10.5 m/s in average, and also due the arability of large inhabitant desert area. Egypt enjoys considerable wind energy resources, with an average wind speed 10 m/s in Gulf of Suez area and an 7 m/s in East Owainat area and Zafrarana region with about 9.5, a wind atlas has been issued for gulf of for Egypt is being developed. A pilot wind farm was built at Hourghada; consist of 42 wind unit (100-300 KW each) with 5.4 MW capacities. Its output has been connected to local electricity grid since 1993.

To successive stages of wind farm at Zafrana (140 MW) have been executed as of year 2001. The estimated electrical energy consumption is more than 570 TWh/year. The energy saving will be more than 125000 TOE/year. The target for total installed capacity of wind energy is about 650 MW in year 2010. A new project was started at Gabal El-Zeit in the Suez Governorate to establish a new wind farm to produce 220 MW.

2.4 Biomass

Production of biomass energy using agriculture, animal, human, and solid wastes has high potential in Egypt. Power generation from gasification of sewage slued in waste water treatment plants (El-Gabal El-Asfer 23 MW plant) is already been used. High potentials projects for power generation based on gasification or direct combustion of organic solid wastes or agricultural wastes are under consideration. A potential of 1000 M could be generated from agriculture waste.

2.5. Solar Distillation

The maximum water allowed from the River Nile is only 55.5 billion m^3 since 30 years ago and the population was doubled in this period (less than 45 million) and the needs for fresh water became vital. The Arab Organization for Industrialization in Egypt manufacture and applying 168 projects in the Read Sea Region to provide this area by fresh water for domestic and Touristic resorts away from the water pipe lines.

3. Egyptian Building Energy Codes

For the past two decades, Government of Egypt (**GOE**) has published three energy efficiency building codes for residential [3], commercial [4] and Governmental Buildings [5] and another code was approved for ventilation [6]. Five energy Label was approved and used in life practice with testing facilities to reduce the electricity consumption in the residential sector. At the time, detailed studies had shown the close line between population growth and energy. The thermal elements for 8 climatic regions are summarized and shown in Table 2. The thermal envelope is very important which includes wall, roof, insulation, windows (ventilation and day-lighting), doors, finishes, weather-strip, and air/vapor retarders.

4. Egyptian Green Building Code

The second draft of Egyptian Building Code was introduced to the Green Building Council for discussion [8]. The main items that considered in the green building draft code for new buildings are Energy Efficiency (EE), Water Efficiency (WE) and Indoor air quality (IA).

5. The Green Pyramid Rating System

The energy efficiency codes were first step to go further to develop the green building code. The Egyptian Green Building Council (**EGBC**) was established in 2009 and consists of both national and international personalities and including governmental ministers from cabinet level agencies, officers from respected NGOs and others. One of the objectives for establishing this council is to provide a mechanism to encourage building investors to adopt the BEEC's as well as other sections of existing codes that satisfy both energy efficiency and environmental conservation. Climate change is the greatest challenge facing humanity, and research appears that the phenomena are a result of increased levels of greenhouse gas emissions resulting from human activity. Estimated that half of total carbon-related emission comes from buildings and their use, sustainable building development and green building. The Government of Egypt, represented by the Ministry of Housing has an interest in promoting green building as part of the Ministry's overall sustainable development policies. GPRS (Green Pyramid Rating System) have been developed. GPRS is a rating system that can redefine the way we think about projects we design in Egypt, [11]. Contemporary design, architecture firms make sure their buildings are green, and seek to award the GPRS certification. Green building should reduce pollution and enhance the efficiency of energy and water use.

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6.1 Category Weightings

The **GPRS** system [12] consists of main topics, like Energy Efficiency, Water Efficiency, and Indoor Air Quality & Atmosphere, and other topics called "credit categories". The building performance regarding each of these credit categories is evaluated. Each category in turn contains several elements that need to be assessed in the building. These elements are either credit Green Pyramid Category Weightings are as follows:

No.	Green Pyramid Category	Category Weighting
1	Sustainable Site, Accessibility, Ecology	10%
2	**Energy Efficiency**	**25%**
3	**Water Efficiency**	**30%**
4	Materials and Resources	10%
5	Indoor Environmental Quality	10%
6	Management	10%
7	Innovate on added Value	5%

It is clear that from the above table that Energy (50 credits) and Water (70 credits) Efficiency are very important Category for Egypt.

The objective of the Energy Efficiency are:1) to reduce energy consumption and carbon emissions by cooperating passive design stage; 2) to optimize the choice of electrical and mechanical equipment, to and evaluate the inventory of energy and carbon for each development MEP system, and to minimize their impact on the environment; 3) to reduce energy demand for loads at peak use times through efficient building and services design and site based through renewable energy generation; 4) to encourage the provision of metering facilities that allow energy performance of the building; 5) to minimize the energy consumed. The maximum credits in this category 12 points renewable energy sources and 6 points to reduce the peak load, followed by 5 points for passive external heat gain reduction, i.e. more 50% The objective of water efficiency are summarized as follows:1) Passive Distillation Systems; 12 points Storm Water Harvesting; 8 points for water efficiency improvements; 8 points for outdoor water efficiency improvements; 8 points for waste water management; 6 points for water leakage detection and 6 points for water feature efficiency total 70 pints credit.

To earn Pyramid Certification a project must satisfy all the stated Mandatory Minimum Requirements and may obtain Credit Points by meeting certain criteria. Projects will be treated based on Credit Points accumulated, according the following rating system:

GPRS Certified : 40 - 49 credit
Silver Pyramid : 50 - 59 credits
Gold Pyramid : 60- 79 credits
Green Pyramid : 80 credits and above

Projects with less than 40 credits will be classified as 'Uncertified'.

Table 3: Green Pyramid Rating Calculation

	A	B	C=A/B*100%	D	E= C*D
Green Pyramid Category	Credits Available	Credits Available	% Credits Achieved	Category Weight	Category Score
1: Sustainable Site, Accessibility, Ecology	10	5	50%	10%	5
2: Energy Efficiency	50	40	80%	25%	20
3: Water Efficiency	70	35	50%	30%	15
4: Materials and Resources	20	15	75%	10%	7.5
5: Indoor Environmental Quality	30	15	50%	10%	5
6: Management	20	10	50%	10%	5
7: Innovation and Added Value	10	0	0%	5%	0
Total	57.5				
Green Pyramid Rating	SILVR				

6.3 Process of Assessment

The assessment used a spreadsheet for evaluation process as follows:

1) For each Category the umber of credits award will be determined by a Green Pyramid;
2) The credit achieved for each Green Pyramid Category is calculated;
3) The percentage of credits achieved is then multiplied by the corresponding Category Weighting. This section score.
4) The scores for each Category are then added to give the overall Green Pyramid Rating, see table (3),

6.4 Green Star Hotels

Tourism is one of the major contributions to Egypt's GDP. It is considered as one of man source of foreign currency, about 15% from the national income after Suez Canal. Green Hotel Rating System [13] became necessary for the Egyptian Touristic sector. A case study [14] was focus on hotels in Red Sea Costal area to estimate the energy efficiency base line and compare with the energy performance of some typical hotels in the Read sea area according to a protocol signed between GIZ and HBRC in 2010, the study in progress not completed yet.

7. Conclusion

This paper presents the potential of Energy Efficiency and Renewable Energy sources with the potential of Green Pyramid Rating System in Egypt. The main conclusions derived from this paper may be summarized as follows:

1) Hydro power from the high dam and other stations contribute about 9% of the total power,
2) Wind Energy is very promising and needs more chair from the private sector,
3) Solar Energy not received much attention, since the electricity is subsidies and must given to SWH for domestic use but incentive and rebate, many projects are started to be in different locations.
4) As long as all petroleum products and natural gas are priced far below value, no level playing field for RE (RE appear too costly) in power generation and decentralized application,
5) he way out to change the instruments; restrict misappropriation, smuggling, wasteful low energy prices to basic energy (and public consumption transportation, and increase the incentives ,
6) Egypt decided to reduce the VAT for efficiency and disincentives for renewable energy equipment.

The Energy crisis threatens the whole world and specially Egypt. It can be summarized in that most of the energy needs in Egypt is dependent upon fossil fuel, whose supply is constantly decreasing while the demand is greatly increasing. Another problem is the pollution growth which greatly threatens the health of all living creatures. A third one is global warming due to the emission of green house gases as byproducts of energy production, a problem that causes the temperature to rise constantly which threatens the life of many species, leads to more energy consumption in cooling and causes floods in areas and droughts in others. As a response to these problems, and as buildings are important contributors to the problems, green buildings have emerged, and green building rating systems like GPRS (Green Pyramid Rating System) have been developed.

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Author Profile

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